Whiteflies cause problems for southern California growers

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A task force of scientists is searching for effective whitefly controls.

During 1981, unusually high whitefly populations on cotton and vegetable crops began causing multiple problems in the desert areas of southern California and western Arizona. The problems included direct plant injury by whitefly feeding, reduced quality of produce and fiber because of honeydew accumulation, and lower crop yields as a result of virus or viruslike diseases carried by the whiteflies. Total estimated economic damage ranged in the millions of dollars: cotton, sugarbeets, squash, melons, and iceberg lettuce were the most seriously injured crops.

Several species of whiteflies are present in California's Imperial and Coachella valleys. Among these are the sweetpotato whitefly (also known as the cotton and tobacco whitefly), *Bemisia tabaci* (Gennadius); banded-wing whitefly, *Trialeurodes abutilonea* (Haldeman); and iris whitefly, *Aleyrodes spiraeoides* Quaintance. The banded-wing whitefly is predominantly found in cotton from early spring to July. In July, populations of the sweetpotato whitefly surpass those of the banded-wing whitefly. The iris whitefly is rarely found and is not a problem on agricultural crops.

Whiteflies are generally found in the tropics and subtropics, roughly corresponding to the area between the 30th parallels. In the tropics they occupy the general ecological niche held by aphids in temperate areas. Sweetpotato whitefly has been reported in parts of Africa, southern Europe, the Middle East, India, Sumatra, Formosa, Brazil, and the southwestern United States. The banded-wing whitefly is found in 33 of the 50 United States, parts of Mexico, and the West Indies.

Biology

Whiteflies are small plant-sucking insects (1 to 3 mm) found on leaf undersurfaces. They are not true flies, but belong to the order Homoptera, which includes aphids, scale insects, and psyllids.

Eggs are deposited on the undersides of leaves and in 5 to 12 days, during the summer, hatch into the crawler stage. The six-legged crawler moves about until it finds a suitable feeding site, usually on the leaf undersurface. Once the crawler inserts its mouthparts (stylets) to feed, it remains at the site until the adult stage. The stylets usually penetrate between the epidermal and parenchyma cells of the leaf to the phloem (path of sugar and nutrient movement).

After feeding begins, the crawler molts and appears scalelike. It continues to feed and passes through two more molts. After the third molt, the whitefly pupates and stops feeding until emergence as an adult.

During the summer, the whitefly develops from egg to adult within 16 to 35 days, depending on the temperature. After emerging from the pupa, adult whiteflies mate, and the females begin to deposit their eggs. Eggs from unmated females produce males only. The female lays approximately 300 eggs in her lifetime. Whiteflies can fly only for short distances, but winds disperse them several miles because of their minute size.

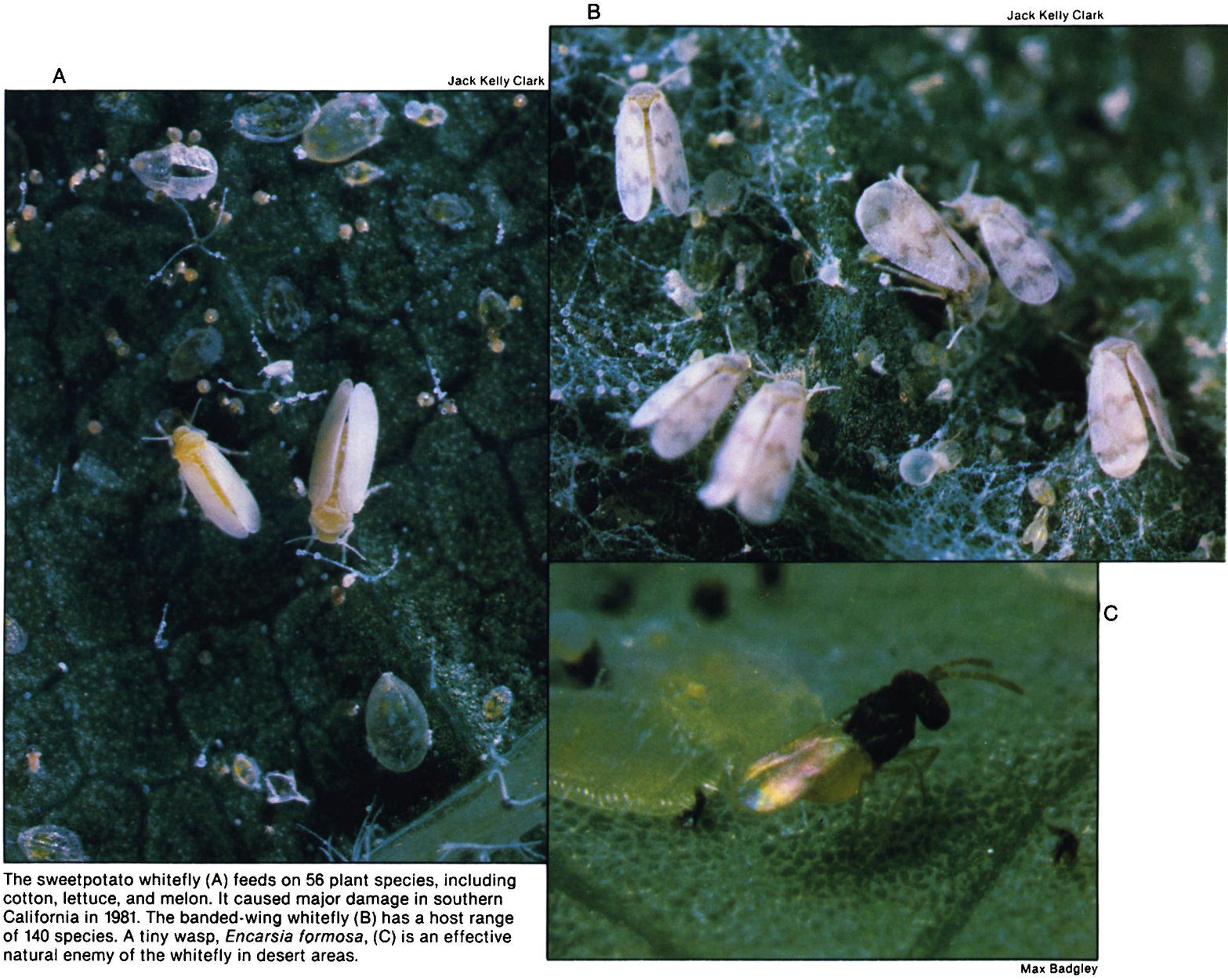
Both of the major whitefly pests in the southern California desert have a wide host plant range. The sweetpotato whitefly reportedly feeds on as many as 56 plant species worldwide. In the Imperial and Coachella valleys, cultivated host plants include cotton, lettuce, squash, cucumbers, and melons, although the whitefly is not known to reproduce on lettuce in the field. Wild hosts include bindweed (*Lantana* spp.), prickly lettuce (*Lactuca serriola*), and *Malva parviflora* L. The banded-wing whitefly has a larger worldwide host range of approximately 140 plant species, several of which grow in southern California.

Crop damage

Whiteflies may injure a crop in a variety of ways. High populations feeding on nutrients may affect the plant's physiological processes, ultimately causing leaf shedding and a reduced growth rate in some crops. Chlorotic spots appear at feeding sites on leaf surfaces.

Vast amounts of honeydew produced by larvae may discolor leaves. In cotton, honeydew falling onto lint in open bolls frequently supports the growth of sooty molds (*Alternaria* spp.). When abundant in the lint, the sticky excretion interferes with picking and ginning. Honeydew contamination results in lower quality fiber that is difficult to spin and thus reduces its market value.

The ability to spread virus or viruslike plant diseases makes high whitefly populations a menace to southern California melon, lettuce, and cotton. Larvae and adults pick up virus particles when they feed on infected



The sweetpotato whitefly (A) feeds on 56 plant species, including cotton, lettuce, and melon. It caused major damage in southern California in 1981. The banded-wing whitefly (B) has a host range of 140 species. A tiny wasp, *Encarsia formosa*, (C) is an effective natural enemy of the whitefly in desert areas.

plants. Adults moving and subsequently feeding on susceptible healthy plants spread the disease. Acquisition of a pathogen from a diseased host plant may take from a few minutes to several hours, depending on the pathogen and whitefly species. Usually, the pathogen may be transmitted over a long distance and period of time, once it has been acquired by a whitefly adult.

The major diseases thought to be spread by whiteflies in the desert areas are cotton leaf crumple, infectious yellows, and cucurbit leaf curl. Several less prominent diseases have also appeared on many vegetable crops. Unfortunately, the viruslike pathogen or pathogens responsible for the three most important diseases have not been positively identified, although several plant pathology laboratories are investigating the problem. Some infested melon crops suffered almost total yield losses in the 1981-82 growing season. Of the three diseases, infectious yellows had the most impact, reducing early-season lettuce production as much as 50 percent.

Population increase

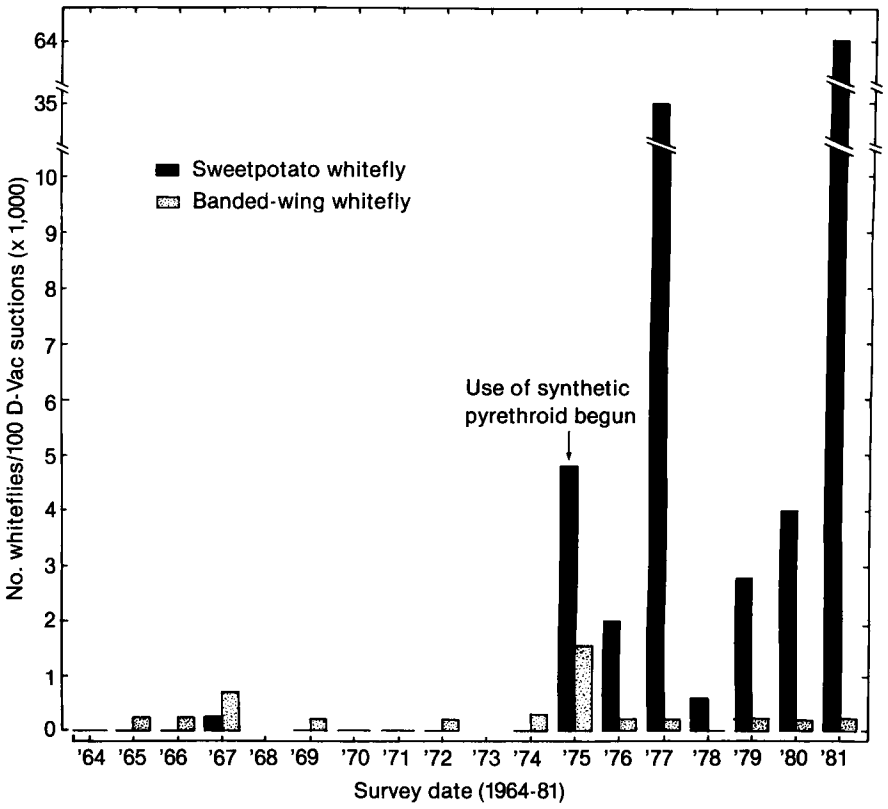
The increased whitefly populations and subsequent spread of viruslike plant diseases in southern California were probably produced by several simultaneously occurring factors. Examination of the typical population cycle of the sweetpotato whitefly in the Imperial and Coachella valleys may provide insight. Basically, whiteflies undergo similar population cycles annually, although large differences in their peak density levels may occur among individual years. The whiteflies overwinter on wild plants such as *Malva* spp. and on available volunteer and stub cotton (regrowth from cut stalks). Stub cotton is not permitted in California, but is found in Arizona. Low winter temperatures inhibit rapid whitefly development. During May, after the spring cotton crop has germinated, whitefly adults move onto young cotton seedlings that have developed their first true leaves.

Unusually warm winters without "killing frosts" experienced in previous years may have allowed large numbers of whiteflies to overwinter, producing abnormally high populations in the spring. Higher initial spring populations may have springboarded from cotton onto susceptible vegetable crops. The presence of cotton not destroyed after harvest, along with wild host plants harboring disease pathogens, may have been responsible for the unexpected epidemic of plant diseases spread by the high numbers of whiteflies.

Whiteflies develop fastest during August

and September when daytime desert temperatures are greater than 100° F. Whitefly population growth, normally checked by natural enemies, was rapid, apparently because pyrethroid-based insecticides used in the area reduced parasite numbers. Records from 1975 to 1981 show an increase in whitefly densities in Imperial Valley experimental cotton plots with the more frequent use of pyrethroids to control the tobacco budworm, *Heliothis virescens* (F.), and the pink bollworm, *Pectinophora gossypiella* (Saunders). Similar outbreaks were reported in Thailand and Sudan in 1980 and 1981, respectively, when pyrethroids were used to treat cotton pests.

After whitefly densities peak in August or September, they decline to a relatively low, stable density until the cotton is harvested or cotton leaves are killed by frost. At this time, winter vegetable crops and wild plants become important overwintering hosts. After vegetable crops are harvested, whiteflies and disease pathogens survive on perennial wild hosts.



Populations of sweetpotato whitefly have ballooned in Imperial Valley cotton.

Control

Conventional pesticide applications do not control whiteflies on cotton. Insecticides may reduce large adult whitefly populations but usually do not affect immatures. The long egg incubation period allows crawlers to emerge long after insecticides have reduced adult populations. The immobile larval and pupal stages have a waxy covering, which generally protects them from insecticides. Materials that kill whitefly immatures cannot be applied effectively by air because of poor pesticide delivery to leaf undersurfaces.

Fortunately, whiteflies in desert areas have several effective natural enemies, such as the tiny parasitic wasps *Encarsia formosa* Gahan and *Eretmocerus haldemani* Howard. Adult female wasps deposit their eggs in the bodies of whitefly larvae and pupae, and parasite larvae feed on the body fluids of the immature whiteflies. *Encarsia formosa* requires 15 days to develop from egg to adult at 75° F. The female parasite lays up to 32 eggs during her lifetime. The immature form of *Eretmocerus haldemani* feeds only on the pupal stage of the whitefly and takes 22 days to develop from egg to adult at 75° F. The value of the whiteflies' natural enemies has been demonstrated many times in various parts of the world. When insecticides such as DDT were applied to control other pests, whitefly parasites were reduced, and whiteflies increased.

Until the major factors contributing to the increase in whiteflies and disease spread can be established, no tested preventive or control measures can be recommended. However, some guidelines exist for decreasing potential whitefly problems. To reduce sources of disease, destruction of all stub cotton and management of weed hosts along roadsides, ditchbanks, and fencerows, and in production acreage is advisable. To conserve natural enemies of whitefly, insecticidal control of budworm and pink bollworm in cotton fields with potential whitefly problems should be conducted with pyrethroids only when absolutely necessary. Immediately after harvest, plant stands should be destroyed to prevent regrowth and the production of weeds that could harbor diseases. Cotton should be terminated early. Lettuce or cucurbit crops should be planted away from mature or obviously disease-infected crops to reduce chances of virus infection by naturally dispersing whiteflies.

Researchers at the University of California, University of Arizona, and the U.S. Department of Agriculture (USDA) are studying the whitefly problem. A whitefly task force of 17 University of California and USDA scientists has proposed several research objectives to determine the causes of and solution to this problem. Plant pathologists are attempting to isolate and characterize the causal agent(s) of whitefly-transmitted diseases in cucurbit and lettuce crops and to develop serological methods for rapid detection of the agents. Lettuce and squash varieties and the "world's collection" of muskmelon varieties are being screened for resistance to whitefly and disease pathogens. In-depth studies of whitefly biology and population dynamics may reveal weak links in the insect's life cycle that can be exploited to control the pest. Investigations into biological and chemical controls of whiteflies and their interactions on cotton and lettuce may produce more efficient management practices.

Field reports indicate that overwintering whitefly population densities are quite low. It is hoped that the whitefly problem in the 1982-83 growing season will be minimal. Fortunately, growers facing the upcoming season will be better prepared to face the whitefly threat if it materializes.

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